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RECRUITMENT OF QUALITY SOLDIERS (THE
CASE OF THE PAKISTANI ARMY)

by

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This thesis studies two aspects of Army manpower: (1) quality issues in the Army manpower, and (2) the influence of economic variables (military compensation, advertising, and unemployment rate) on enlistment decision of the youth population, particularly high quality Army recruits. The level of education and scores on applicants' aptitude tests are the basic determinants of soldier quality. However, military training and environmental factors help to improve the quality of soldiers. With regards to the impact of economic variables, basic military pay and education incentives, that is "money for college education," have major influences on enlistment decision of potential high quality recruits. Advertising and unemployment rates also have considerable impact on the enlistment decision. Following a discussion on quality and influence

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**Recruitment of Quality Soldiers
(The Case of the Pakistani Army)**

by

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This thesis studies two aspects of Army manpower: (1) quality issues in the Army manpower, and (2) the influence of economic variables (military compensation, advertising, and unemployment rate) on enlistment decision of the youth population, particularly high quality Army recruits. The level of education and scores on applicants' aptitude tests are the basic determinants of soldier quality. However, military training and environmental factors help to improve the quality of soldiers. With regards to the impact of economic variables, basic military pay and education incentives, that is "money for college education," have major influences on enlistment decision of potential high quality recruits. Advertising and unemployment rates also have considerable impact on the enlistment decision. Following a discussion on quality and influence of economic variables, a model is formulated to minimize the Army's total costs subject to a given level of readiness. The model helps to determine the effect of changes in the Army readiness level, education level, unit advertising costs, unit training costs, unemployment rate, and unit equipment costs on the decision variables (manpower level, equipment level, advertising expense/cost, and training expense/cost).

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I. INTRODUCTION

A. BACKGROUND

This thesis concentrates on two aspects of military manpower: the definition of a quality soldier in today's army, and the impact of economic variables (particularly military compensation), on the enlistment and retention decision of potential recruits.

The success of all-volunteer forces depends on the ability of individual military services to meet their requirements in terms of both the quantity and quality of active duty personnel. The requirement for quality soldiers was introduced by the United States (U.S) military in the beginning of the last decade. It has now gained wide acceptance, not only in the U.S. but in the other countries who maintain all-volunteer military forces. Pakistan is one of these.

Unfortunately our adversary (India) is approximately ten times bigger in population and about four times larger in geographic size. Therefore, Pakistan does not compare well with India in total military strength. Further, India's goals appear to be the effective application of military power to achieve its political aspirations and impose its will on neighboring countries. It is obvious that Pakistan can not match its adversary man for man or gun for gun. This emphasizes the need for quality soldiers who can effectively

defend their country when called upon to do so. The objective is to match quantity with quality.

The advent of more sophisticated weapon systems further augments the need for quality soldiers. A group of leading U.S corporate executives, government officials and educators contend that the high technology embodied in current weapon systems will increase the skill requirements for a variety of technical occupations and require higher levels of education to operate [Ref. 1:p. 36]. This issue, along with the definition of a quality soldier, is discussed in Chapter II.

Pakistan is in the middle of an era of industrial development. There has been significant industrial growth during the last decade. During the period 1980-1987, industrial production increased by an average of 9.1 percent annually. By the end of 1989, about 20 percent of the work force was employed in the industrial sector, which contributed 24 percent of the Gross Domestic Product (GDP). Details are provided in Table 1.1 [Ref. 2:p. 1994].

TABLE 1.1

GROWTH OF INDUSTRIAL PRODUCTION (PAKISTAN)

Year	% of Work Population	% of GDP
	Employed	Provided
1978	13	14
1978	13	20
1989	20	24

Although a major benefit to the economy, development in the industrial sector makes it harder for the Armed Forces in general, and the Army in particular (which employs almost 90 percent of military manpower) to meet its manpower requirements. Industrial development offers alternative employment opportunities to the work force and provides increased competition in the labor market.

The concept of an all-volunteer military would compel the Army to recruit on a competitive basis with the civilian sector. Its success will depend both on the recruitment strategy of the Army and on the enlistment decision taken by individuals qualified for military service.

The Army is neither a pure price taker nor a pure quantity taker. Rather, it attempts to fill its manpower requirement using a predetermined wage. The recruit quality varies to equate supply and demand. Thus, the number of quality recruits is supply determined, but the total number of recruits reflects both supply and demand forces [Ref. 3:p. 3]. Figure 1.1 illustrates this point. Holding other factors constant, the supply curve is drawn as a function of military compensation relative to civilian compensation. Demand for enlistment is determined by considerations of force size and structure, in the short term. If the relative wage is W_1, demand exceeds supply and actual enlistment will be given by E_1. At W_2, military compensation is relatively more attractive, demand becomes the constraining factor and

enlistment equals E_2. However the appropriate compensation is W_0, where supply equals the demand. Chapter III analyses the influence of various forms of compensation on individual enlistment decisions.

The purpose of this study is to examine the influence of economic variables on the enlistment decision of quality recruits. Based on an analysis of economic factors, a cost effective recruitment model is developed for the Army. The model developed in this study represents an effort to assist the Army in minimizing its recruitment costs without compromising on the quality of recruits.
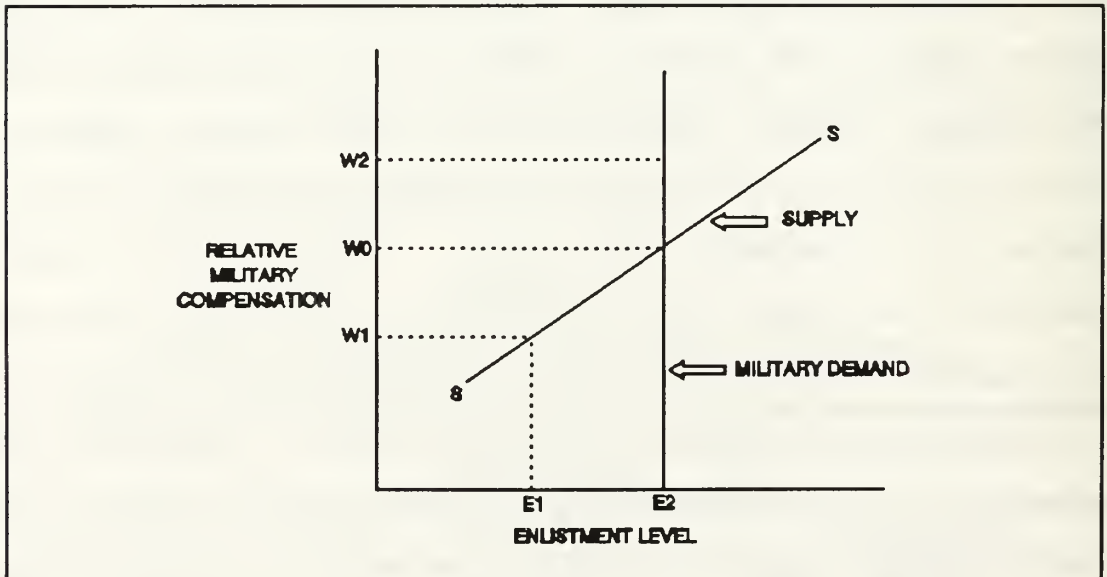
Figure 1.1

Effect of Supply and Demand/Quota on Enlistment

B. PURPOSE AND SCOPE OF THE THESIS

The purpose of this study is threefold. First, to understand the influence of economic variables on recruitment. Second, to draw on the experience of the U.S. Army, particularly concerning the quality of military recruits. And finally, to recommend measures for improvement of recruitment methodology in the Pakistan Army.

C. RESEARCH OBJECTIVES

This study focuses on the three research objectives outlined above. The first objective is to explore the issue of quality concerning Army recruits in order to provide answers to the following questions: What is a quality soldier and how is quality ascertained in the U.S. Army? What are the benefits and costs of quality soldiers?

The second objective is to test economic variables, specifically military compensation relative to civilian compensation, military advertising expenditures and the unemployment rate, to determine their influence on the recruitment of quality soldiers in the Army.

The third and final objective is to propose a model for future use, along with policy implications, for the Pakistan Army.

D. LIMITATIONS

The non-availability of required data from the Pakistan Army is a major limitation of this study. However, in order

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to draw appropriate inferences and to ascertain the validity of the theoretical aspects, data pertaining to the U.S. Army will be used.

E. ORGANIZATION OF THE STUDY

In addition to the introduction in Chapter I, there are four more chapters of the thesis. In Chapter II, the concept of quality soldier is discussed. It includes a definition of quality soldier, the U.S. Army's perception of quality, a benefit-cost analysis of quality soldiers, and an examination of quality as a function of training and environmental factors (motivation etc).

Chapter III examines the influence of economic variables, including compensation, advertising and unemployment, on the enlistment decision of potential recruits.

As a result of the discussion in Chapters II and III, a model to minimize costs is developed and discussed in Chapter IV. Here the objective function is to minimize Army costs while maintaining a given level of readiness.

Chapter V summarizes the conclusions drawn from the study and offers recommendations for the improvement of recruitment methodology and the quality of recruits in the Pakistan Army.

II. QUALITY

This chapter of the thesis explores four areas pertaining to the quality of military manpower: (A) the requirements of quality soldiers, (B) the U.S. Army's perception of quality, (C) quality as a function of training and environmental factors, and (D) benefit-cost considerations of quality soldiers.

A. THE REQUIREMENT FOR QUALITY SOLDIER

1. Technology

In the future, advances in technology will play a prominent role in shaping the work force. Much will depend on the design characteristics of military hardware, especially its complexity, reliability and maintainability. The new weapon systems will demand ever-more-skillful operators and mechanics to exploit the full capabilities of the weapon systems. The failure of Israeli soldiers to properly operate the Patriot Missile System during the Gulf War provides a recent example of soldier capability vs the complexity of the weapon system.

Rapid increases in military technology have prompted several studies concerning the requirement for high quality personnel in the U.S. Army. For example, the U.S. Army 21 Study, a research project undertaken to determine manpower requirements in defense, predicted that demand for quality

soldiers will continue to increase in the future. The study concluded that the "future soldier must be able to make rapid independent decisions and be better educated, have an expert level of technological understanding. Such a multi-capable soldier besides being a good fighter, must clearly score high on quality measures used by the DOD, that is, on aptitude tests and educational levels" [Ref. 4:p. 15].

While there are a number of rapidly evolving technologies, the microelectronics revolution is the most important. It is expected to have a pervasive impact on all forms of warfare. Its vast applications enhance the Army's major capabilities, including: command, control and communication; reconnaissance; surveillance and target acquisition; battle field intelligence, etc. These applications require high quality operators who can collect, translate, classify, interpret and analyze data.

The procurement cost of weapon systems is another area of concern. The growth in technology is accompanied by manifold increases in the procurement costs of weapon systems. Thus, unless the force is manned by soldiers capable of operating and maintaining modern weapon systems, the capital investment in enhanced technology will not yield the anticipated return.

Therefore, prudent planners should anticipate that the Army's requirements for bright, technologically literate individuals are likely to increase in the years ahead.

2. Junior Leadership and Management

Non-commissioned officers (NCOs) are the back bone of the professional Army. NCOs provide leadership for individual soldiers and manage the actions of small units or sections. They have a significant impact on the morale of soldiers and the attitude within a unit. NCOs must posses strong values, articulate ideas and demonstrate competence. Such quality individuals must come from the cohort of enlistees. Therefore, it is necessary to increase the quality of inductees to improve the quality of the career force.

B. U.S. ARMY PERCEPTION OF QUALITY

The U.S. Army Recruiting Command primarily uses two criteria to determine the quality of a potential recruit: an individual's performance on the Armed Services Vocational Aptitude Battery (ASVAB) and the level of education attained. The official definition of a quality soldier as defined by the DOD is, "the high quality soldier is--one who is a high school diploma graduate (HSDG) and has a percentile score of 50 or higher on the armed forces qualification test (AFQT)" [Ref. 5:p. 10].

The U.S. Army places a high premium on educational attainment, not so much because of its relationship to mental achievement, although this is important for some technical training, but because of its implications for general adaptability to the military environment. According to the DOD, a high school diploma" is the best single measure of a person's

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potential for adapting to life in the military." [Ref. 6:p. 6] The evidence provided cites that on average, high school diploma graduates (HSDG) are involved in fewer disciplinary incidents, are promoted more quickly, are more likely to attain eligibility to reenlist, and above all tend to perform successfully in the military.

Aptitude tests play an important part in determining eligibility for entry, not only into the Army but also for initial training programs. The ASVAB, administered to all applicants, is composed of ten subtests, as shown in Table 2.1. Scores on these tests are used by the Army in two ways: (1) to measure military trainability in a single index, the AFQT score, and (2) to asses vocational aptitude for specific job categories.

The AFQT score, a measure of trainability, is computed from four of the ten subtests which comprise the ASVAB. Four subtests used are: world knowledge, paragraph comprehension, arithmetic reasoning and numerical operation. The AFQT score is then used to determine the applicant's mental group category. On the basis of these scores individuals are divided into five categories as shown in Table 2.2.

The AFQT scores are used principally to differentiate between categories I and II (above average), III (average), and IV and V (below average). To delineate the top and bottom half of the population, category III is sometimes divided in

TABLE 2.1

ASVAB SUBTESTS DESCRIPTION

ASVAB Subtest	Number of Questions	Testing Time (minutes)
General Science	25	11
Arithmetic Reasoning	30	36
Word Knowledge	35	11
Paragraph Comprehension	15	19
Numerical Operations	50	3
Coding Speed	84	7
Auto and Shop Information	25	11
Mathematics Knowledge	25	24
Mechanical Comprehension	25	19
Electronics Information	20	9
All Subtests	334	144

[Ref. 7:p. 68]

TABLE 2.2

PERCENTILE LIMITS FOR AFQT SCORE

Mental Category	AFQT Percentile Score	Percentage
I	93-99	8%
II	65-92	28%
IIIA	93-99	15%
IIIB	31-49	19%
IV	10-30	21%
V	1-9	9%

[Ref. 7:p. 74]

two groups as shown in Table 2.2. The applicants falling in to the lowest category (10 Percent of the youth population), are by law not eligible for military service.

From the discussion above, it is concluded that quality is a function of AFQT scores and the level of education. The higher the AFQT score and the level of education, the higher the quality, and vice versa. Mathematically:

$$L = f(A , E)$$ (2.1)

where: L   represents quality (marginal productivity) of an individual recruit

A   represents the AFQT Score

E   represents the level of education.

C.   QUALITY AS A FUNCTION OF ENVIRONMENTAL FACTORS AND TRAINING

1.   Environmental Factors

According to Maslow's motivation theory of "need hierarchy" (Table. 2.3), the behavior of workers is dominated and determined by needs that are unfulfilled. Social needs fall in the middle of the "need hierarchy." Therefore, these play an important part in worker motivation. By virtue of defined rules and regulations in the Army, the physiological needs, safety needs, self esteem needs and self actualization needs are automatically fulfilled. However, social needs resist measure and are not provided appropriate attention by military leaders. Thus, these needs not only influence a

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TABLE 2.3

MASLOW'S NEED HIERARCHY

Need	Description
Self-actualization needs ↑	Realization of one's full potential.
Self-esteem needs ↑	Includes self confidence, recognition, appreciation and respect of one's peers.
Social needs ↑	Desire of association, belongings, companionship, and friendship.
Safety needs ↑	Freedom from threat, danger and deprivation.
Physiological needs	Need for survival, including food, clothing and accommodation etc.

[Ref. 9:p. 347]

soldier's behavior, but also affect the organizational and unit environment.

Military leaders and behavioral theorist recognize the importance of the individual socialization process, and the values internalized from that process, as an environmental influence on quality. General Donn A. Starry, former Commander of the U.S. Army Training and Doctrine Command, stated in the Army's 1980-1981 Green Book that "training and soldier performance are influenced by motivation more than any other single factor or combination of factors, and that motivation comes from values, shared hardship and solid leadership" [Ref. 8:p. 28].

Similarly, Major Stephen D. Wesbrock, U.S. Army, studying soldiers attitude towards the Army and society in general, found that: (1) sociopolitical alienation of soldiers is a major threat to the Army, and (2) alienation is negatively correlated with morale, proficiency and discipline. As alienation increases, job satisfaction, job performance, reliability and discipline correspondingly decrease. [Ref. 8:p. 31].

The above discussion indicates that quality is a function of education, AFQT scores, and environmental influences. Therefore, a new expression for quality would be:

$$L = f(A, E, I) \tag{2.2}$$

Where: A Represents AFQT scores or trainability

E Represents the level of education

I Rpresents the environmental influence

2. Training

According to human capital theory, workers undertake two major kinds of investment: education, and training. To emphasize the essential similarities of these investments, economists refer to them as "investments in human capital." When investment expenses are born by the employer, as is case with the Army, it is aimed at improving the skills and knowledge of its workers. Therefore, from an economics point of view, training workers is meant to increase their productivity [Ref. 10:p. 324].

From the military point of view, <u>productivity is referred to as the quality or performance</u>. It is an article of military faith that good training conducted by good and dedicated leaders will overcome mental inaptitude of trainees. Indeed, historical examples tend to substantiate this view. The following comments were made in a U.S. Army War College paper by Lieutenant Colonel Richard B. Cole and are representative of his contemporaries and of this philosophy:

Today's soldier, will respond to leadership and group norms. If they are good he will be a motivated and responsible team player. He will learn from good training given by competent leadership. He is a reflection of his leaders, he can be fine soldier or a dud. If his leaders give a damn, so will he and he will produce; if they do not, he will be either non-productive or counter-productive [Ref. 8:p. 23].

The above reasoning supports the economic argument that quality (productivity) of workers can be enhanced through meaningful training. Therefore, soldier quality can be expressed as:

$$L = f(A, E, I, T) \tag{2.3}$$

Where: T represents the amount and type of training.

The implications of equation (2.3) are as follows:

a. The quality of a soldier can be enhanced by improving all four factors or any combination of individual factors. However, the increment in quality depends on the importance of the factor concerned.

b. Individuals differ in their level of education, mental abilities, trainability, and level of motivational

values. Therefore, there are many categories of soldiers.

c. The level of education and AFQT scores are exogenous to the system. Therefore, the quality can only be enhanced, in these areas, by recruiting soldiers with either a higher education level or a higher AFQT score.

d. The environmental factors and training are endogenous to the system. The Army has control over these factors. The influence of environmental factors resists measure and is more a matter of recognition by the military leaders. A concerted effort at all levels of leadership can make the difference. Therefore, for the purpose of model formulation (Chapter IV), it has been treated as exogenous to the system.

e. The Army can enhance quality through training. If the same amount of training is imparted to all soldiers, then they will differ in their performance (productivity). To achieve the same level of performance, the lower quality recruits would require more training.

In order to simplify our further discussion and limit its scope, recruits are divided into two categories: (1) high quality recruits; those who are high school graduates and have AFQT scores in the upper 50 percent (A_1, E_1), and (2) low quality recruits; those who are non high school graduates and have AFQT scores in the lower 50 percent (A_2, E_2). Therefore, the quality equation (2.3) is divided into two equations for better understanding:

$$L_1 = f(A_1, E_1, \bar{I}, T_1) \tag{2.4}$$

$$\text{and} \quad L_2 = f(A_2, E_2, \bar{I}, T_2) \tag{2.5}$$

Where: L_1 represents high quality recruits

L_2 represents low quality recruits

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D. BENEFIT-COST ANALYSIS OF QUALITY SOLDIER

1. Benefits

The four pillars of Army manpower revolve around readiness, sustainability, modernization and force structure. Readiness is a function of training (war fighting capability) and discipline. Sustainability includes the retention of qualified soldiers in the Army. Modernization is the advancement of technology in order to have superiority or at least parity with the threat. The last pillar, force structure, ensures that the forces are organized and structured properly so that the Army can accomplish its intended mission. This part of the thesis identifies the impact of quality soldiers on the first two pillars: readiness, and sustainability.

There are four easily identified benefits to the Army of recruiting high quality individuals. The first benefit is performance. As equipment becomes increasingly sophisticated, increased productivity in Army manpower will translate into cost savings and increased force readiness. Second, quality soldiers create fewer discipline problems. Third, quality recruits tend to complete their tenure more often than their counter parts. Finally, quality recruits are more trainable. These benefits can not be easily measured quantitatively in the Army for obvious reasons. However, analysis in the succeeding paragraphs provides detailed insights to these benefits.

a. Performance/effectiveness

Productivity in the Army refers to the performance of its people. Although skills attained during peace time may not reflect the true productivity of soldiers during combat, they are valid predictors of soldier effectiveness. During peace time, the results of field training and simulation exercises provide useful indicators of soldier performance in combat. The data in Table 2.4 indicate that people having high AFQT score are more effective than those having low scores, at least in simulations. The data in Table 2.4 are based on the results achieved by American tank crews at the 1982 NATO Canadian Army Trophy tank gunnery competitions conducted at the Granfenwocher tank gunnery range in Germany. The data show the results for a Red (Russian) and Blue (American) tank battle simulation.

TABLE 2.4

RED-BLUE TANK BATTLE SIMULATION

Blue Tank Commander's   Blue-Red

Blue Tank Commander's AFQT Category	Blue-Red Kill Ratio
II	1 to 7.45
IV	1 to 1.5

[Ref. 11:p. 7]

The results of the simulation indicate that a blue tank with a tank commander scoring in category II on the AFQT

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achieved a combat kill effectiveness that is equivalent to six tanks commanded by soldiers scoring in category IV. This implies substitution possibilities within various categories of soldiers. For example, one higher quality commander can be a substitute for six low quality commanders and vice versa. Therefore, other things constant, the Army should prefer soldiers who can operate or maintain equipment effectively to those who can not.

Several studies about soldier performance agree that mentally competent people perform better, make good leaders and contribute significantly to success in battle. These studies conclude that a soldier's mental ability is positively and significantly correlated to combat effectiveness. For example, the Human Resource Organization (HumRRO) in Korea undertook studies to identify the characteristics that differentiate the "fighter" from "non-fighter" in combat. HumRRO found 11 significant characteristics. The most important was intelligence [Ref. 4:p. 11].

b. **Discipline**

Social behavior and discipline of soldiers is an important aspect of cost and combat effectiveness. Absence without leave (AWOL), desertion, crimes committed by soldiers, and other types of delinquency reduce the effectiveness of the military and impose a great cost burden. It costs the Army a vast amount of time in administering judicial and non-judicial punishment. This comes at the expense of training,

maintenance, and other critical matters relating to leadership and management.

Although figures for the cost of discipline problems in the Army are not collected, rough estimates of the cost can be made. For example, the United States General Accounting Office (GAO) estimated the cost of military AWOLs, for the three year period from July 1974 through July 1977, as 1.1 billion [Ref. 12:p. 11]. The GAO also found that "better educated and more intelligent people are on the whole better able to adjust to military life and are far less likely to involve themselves in disciplinary problems." [Ref. 12:p. 11]

Therefore, generally speaking, high quality soldiers perform better, avoid confrontation with laws and regulations, and contribute rather than detract. On the other hand, the frequency of AWOL and desertion in the low mental ability group has always been higher. The data in Tables 2.5 and 2.6 confirm the above argument.

In addition to monetary costs, the poor discipline of low quality soldiers also imposes the following costs on the Army.

* Loss of public support resulting from adverse publicity on discipline problems and ineffectiveness.

* Lowering Army morale.

* More difficult recruiting.

TABLE 2.5

AWOL RATES
(Per 1000 First-term Male Soldiers)

Time in Service	HSDG[2]	NHSDG[1]
1 year or less	11.3	39.8
1 to 2 years	31.0	74.9
2 to 3 years	16.8	45.1
All	19.5	55.4

[Ref. 13:p. 61]

[1]Non high school graduate
[2]High school graduate

TABLE 2.6

DESERTION RATES

FY	HSDG	NHSDG
1980	0.9%	4.5%
1980	2.2%	8.1%
1980	2.4%	8.6%
1977	2.6%	8.0%
1976	1.2%	4.1%

[Ref. 13:p. 62]

* Lower retention rates.

* Perception by adversaries of a weakening of defense, leading to a loss of deterrence.

c. Retention vs Attrition

Military attrition, like civilian job separation, depends on how an individual's skills and interests interact

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with service goals and objectives. Although military restrictions do not explicitly allow recruits to quit, as in civilian jobs, dissatisfied recruits can be discharged on disciplinary or inefficiency grounds. Higher levels of attrition are costly to the Army who must train replacement personnel while enduring unit instability.

In addition to high quality recruits, the retention of quality soldiers is equally important to satisfy the goal of sustainability. A number of studies conducted in the U.S (for example, Defense, 1985; Fernander, 1985: Buddin, 1984) have concluded that high quality recruits had attrition rates about half those of low quality recruits [Ref. 5:p. 1].

d. Trainability

The AFQT score is accepted as a measure of trainability and used to assess the trainability of applicants in the U.S. Army. Percentile scores ranging from 1 to 99 "reflect a person's trainability relative to that of the general youth population" [Ref. 14:p. 73]. Persons with higher AFQT score are easier to train and more likely to acquire the skills and knowledge required to perform their military assignments. This aspect of quality soldiers contributes to their lower training costs.

2. Costs

Recruiting high quality soldiers, defined both in terms of above average AFQT score and a high school diploma, is economically expensive. The breakdown of total costs

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(discussed in more detail in Chapter III) into its components provides a better picture of the problem. The Army's total manpower costs can be divided into four broad categories: recruitment costs, compensation costs, training costs, and monitoring/discipline costs.

a. Recruitment Costs

The recruitment costs of high quality soldiers are higher, as compared to low quality soldiers, for two reasons. First, substantial recruiting resources (advertising, recruiters, etc.) are required to attract these individuals to the Army. A well planned and creative advertising campaign is required to motivate these individuals to opt for the military service. In addition to advertising, recruiters are required to cultivate contacts with high school seniors, particularly in remote areas where advertising is not effective. Second, examining and processing costs have a mushrooming effect, because the search for quality requires more leads (see Chapter III for details).

b. Compensation

The compensation demanded by high quality soldiers is higher. They invest more in the human capital and, thus, have more alternative employment opportunities (i.e., higher opportunity cost). More productive workers demand higher wages. Secondly, they are future oriented and are better able to qualify for "money for college education" (see Chapter III). However, this incentive is applicable only in the U.S.

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Army and provision of the same may not be financially feasible in the Pakistan Army. To assess its cost effectiveness, in the Pakistan Army, would require a detailed study on the subject.

c. Monitoring/Discipline Costs

As discussed above, AWOL, desertions, etc., reduce the effectiveness of the Army and impose a great cost burden. Guarding against such incidents requires close supervision and monitoring. The proportion of such behavior is higher in low quality soldiers. In addition, it requires a vast amount of time and effort to administer the disciplinary cases. These costs are very low for high quality soldiers.

d. Training Costs

High quality soldiers are less expensive to train and more flexible in the workplace. If the objective is to achieve a given level of performance (productivity), high quality soldiers can achieve this level with less training compared to low quality soldiers. Alternatively, higher quality soldiers will acquire a higher level of performance (higher productivity) for a given level of training. Therefore, generally speaking, training costs for higher quality soldiers are low.

Total costs are summarized in Table 2.6. High quality soldiers are more expensive than low quality soldiers in some cases and less expensive in others. Overall, high quality soldiers are likely to cost more than low quality

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soldiers.   This conclusion is based on the following
assumptions:

  a. Recruitment costs and compensation are major cost
      components.   These are higher in case of high quality
      soldiers.

  b. The duration for basic as well as advance training, in
      the Army, is generally fixed.   In addition, it may not
      be economical to conduct separate training for each
      category of recruits because of resource constraints.
      However, substantial cost savings can be realized as the
      average quality of soldiers improves.

TABLE 2.7

SUMMARY - TOTAL MANPOWER COSTS

Cost Component	High Quality	Low Quality
Recruitment Costs	High	Low
Compensation Costs	High	Low
Monitoring/Discipline	Very Low	High
Training Costs	Low	High

While high quality soldiers cost more than low
quality soldiers, it is important to balance the high costs
with the extra benefits gained (as discussed above) before
reaching any conclusion regarding the optimal quality level.
The productivity or effectiveness gained in a specific area
may result in other benefits that are well worth the extra
cost.   Juri Toomepuu of U.S. Army supports this view.   He
notes that small increments of extra effectiveness may well
result in worthwhile benefits, such as lives saved, battles
decided, or wars won.   Therefore, although high quality
soldiers cost more, they may still be cost effective.

III. ECONOMIC VARIABLES

This chapter analyzes the influence of economic variables, including various types of compensation, advertising, and general economic conditions on enlistment decisions by potential recruits.

A. COMPENSATION

The employers' compensation policies, both at one point in time and over time, influence the worker's decision to enter or quit the labor force. What ultimately matters to the workers is the total compensation they receive per unit of time or per product/service produced. To attract higher quality workers, employers must understand the compensation equation.   The best method of compensation is that which offers a strong incentive for the employees but is not too costly for the employers.

1. Elements of Compensation and Their Impact

Generally, a compensation system has two major elements: wages/salary and benefits.   In a competitive economy, the wage rate depends on worker productivity, the demand and supply of workers, and the job characteristics (work environments, etc.). More specifically, the interaction of labor supply and demand determine the market wage rate. Worker productivity is the most important factor in determining the demand for labor.   The higher worker

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productivity, the higher the demand for labor, and vice versa. Furthermore, the wage rate increases with the demand for labor. As discussed in Chapter II, high quality workers are more productive because they are better educated and are less expensive to train. Thus, quality workers receive higher wages because demand is higher for their services.

Changes in factors other than the wage rate, for example population, technology, competition in the labor market, etc., also affect the market wage rate. These changes shift the demand/supply curve of labor. Both the leftward shift in the supply curve or the rightward shift in the demand curve leads to an increase in the market wage rate.

Industrial development increase the demand for labor by increasing competition in the labor market, particularly for quality workers. A shift in the demand curve of labor to the right causes excess demand for quality workers at the current wage. The shift in the demand curve establishes a new market equilibrium wage rate. Figure 3.1 explains this aspect graphically. W_0 and L_0 are the market equilibrium wage rate and employment level before industrial development. W_1 and L_1 are the market equilibrium wage rate and employment level as a result of industrial development. Notice there is an increase in both the wage rate and employment level.
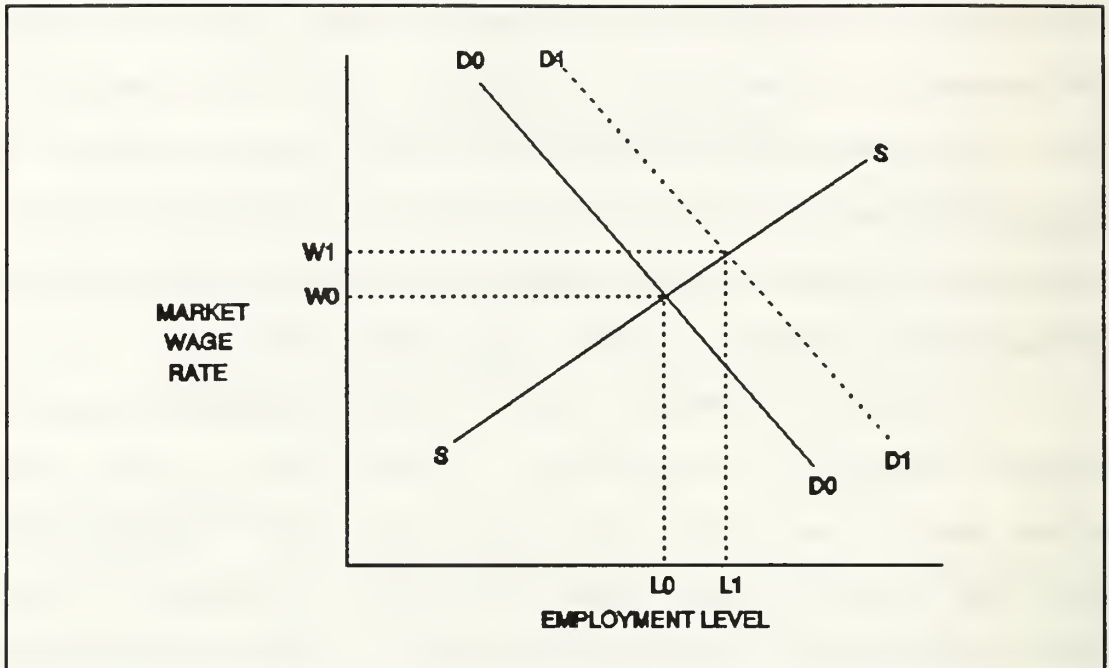
Figure 3.1

Effect Of Competition On The Labor Demand

As discussed in Chapter I, the number of quality recruits in the Army is determined by quotas. The military employer attempts to fill these quotas with the required quality of labor. The wage, however, may have some influence on the demand for quality soldiers by the Army. This aspect is even more important in developing countries because of binding resource constraints. Therefore, any increase in competition from the civil sector makes it harder for the Army to meet its requirement for quality soldiers.

The competition from the civilian sector affects the Army in two ways. Over time the Army is required to readjust its compensation level to match market compensation in order to recruit quality soldiers. In the short run, the Army might

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face a shortage of quality soldiers, either due to budget constraints (if it decides to increase its compensation level) or an inadequate supply of quality soldiers (if the wage rate is below the market equilibrium level, say w_0).

Figure 3.2 explains this phenomenon graphically. With a fixed budget ($B = w_0.L_0 = w_1.L_1$), the Army can afford fewer high quality soldiers (L_1) at a higher wage rate (w_1) than it can afford at lower wage rate ($L_0, w0$). If the Army does not offer the market wage rate, then it will not be able to attract desired quality of soldiers in a competitive economy. It may be able to enlist recruits, but they will not be not be from the same high quality labor market.

Job characteristics and the work environment (for example, risk of injury or death, etc.) are other factors which affect compensation. One of the major functions of the labor market is to provide the signals and mechanisms by which workers seeking to maximize their utility can be matched to employers trying to maximize their profit (or minimize costs). Matching is a formidable task, because workers vary in skills and preferences while employers offer jobs that differ in skill content and working environment, etc. Therefore, worker preferences and job characteristics influence the individual decision to choose one job over another.

B = W0 • L0 = W1 • L1
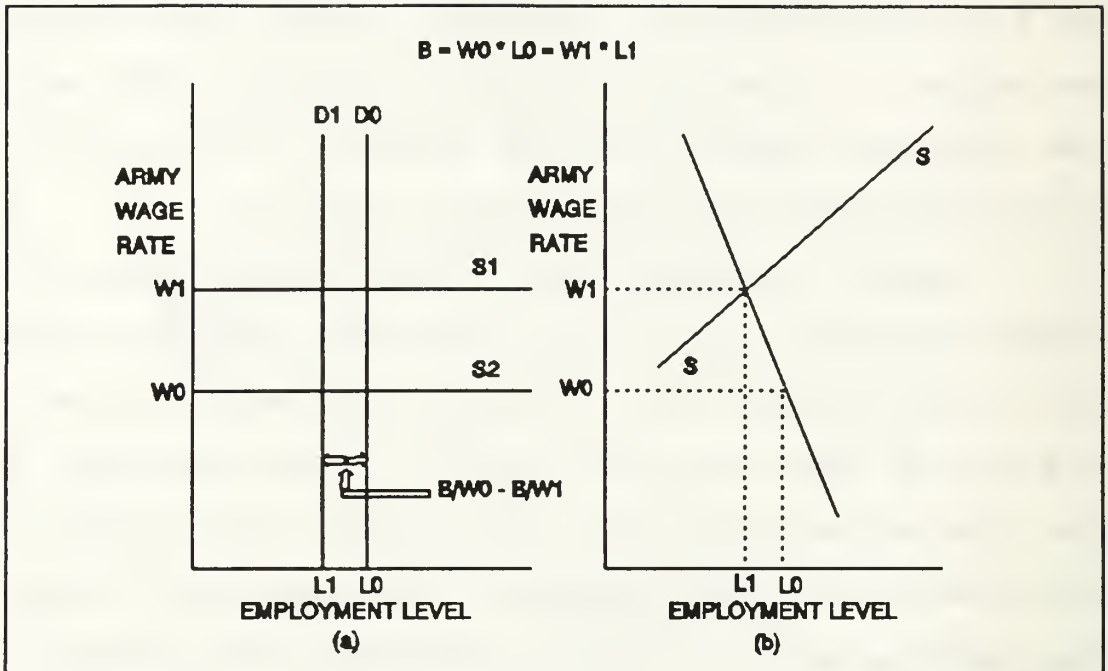
$$B = w_0 . L_1 = w_1 . L_1$$

Slope of the demand curve = $\dfrac{- w_0 . L_1}{B}$

Figure 3.2

**Budget Constrained Quota Setting Demand
For Quality Soldiers**

In order to compensate for a poor work environment, firms offer compensating wage differentials. Firms where risk of injury or death are higher, typically pay higher wage rates to attract the desired quality workers [Ref. 10:p. 273]. Thus, wage rate depends on worker productivity (level of education/ skills, etc.) and job characteristics/work environments.

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Benefits is the second element of a compensation system. There are two broad categories of benefits: payments in kind and differed compensation. Examples of payment in kind are: employer provided health care or health insurance, company provided transportation, etc. Deferred payments include pension benefits, etc. The amount of benefits affects the total compensation provided to the workers and also their utility.

In job selection, workers maximize their utility. Utility is a function of total compensation, that is wages, benefits, and leisure time. An increase in any one factor of utility, while holding others constant, increases workers' total utility. For example, an increase in benefits, while holding the wage rate and leisure constant, increases worker utility. Therefore, benefits are an important element of the compensation system.

2. Military Compensation System

Unlike civilian compensation, the military compensation package consists of a wide assortment of wages, allowances and benefits. By convention, these elements are grouped into three broad categories: regular compensation, special pays and benefits [Ref. 15:p. 15]. Regular compensation includes basic pay, allowances, and tax advantages. Special pay is a form of compensating wage differentials. It is used for special purposes and constitutes a very small percentage of total compensation. For example, such payment constituted

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less than 2 percent of the total military compensation in U.S. in fiscal 1978 [Ref. 15:p. 17]. Therefore, it is not discussed in this thesis. Major benefits to the military services include: education and training, medical and dental support, retirement pay, family housing, etc. Some additional benefits in the U.S. include money for college education, commissaries and exchanges, and government contributions to social security.

Conceptually, the military compensation system is not much different than civilian compensation systems, but there are some unique factors. The principles discussed below highlight the peculiar aspects pertaining to military compensation. Together they form the bases of military compensation [Ref. 16:p. 6].

a. Manpower/Compensation Interrelationship

The compensation system should be an integral part of the overall system by which military manpower is managed. The compensation system must support defense manpower policies, which in turn support the nation's military strategic and operational plans. If they do not, then manpower imbalances (e.g., shortage of high quality labor and surpluses of low quality labor), deteriorating unit cohesion and integrity, poor morale, and general degradation of discipline and motivation are likely to ensue. Therefore, compensation of the members of the armed forces must be

synchronized with military manpower requirements and set with a keen awareness of the national labor market.

b. Compatibility With Technology and Tactics

Military compensation should reflect the realities of the high level of technology employed by the armed forces and combat tactics of today's battlefield environments. The effect of changing combat tactics (often resulting from the characteristics of new weapons) is most noticeable in certain special and incentive pays (e.g., aviation pay, etc.), but it permeates the military compensation system. The introduction of new, high performance weapons and their effects on combat tactics often lead to a review of required labor characteristics and military compensation [Ref. 16:p. 7]. Therefore, the importance of keeping military compensation synchronized with combat tactics is a cardinal percept that can't be over stressed.

c. Equity

The third principle is that of equity, in the sense of "fairness." Few things are more important for morale than service members believing that they are being treated as fairly as possible. Conversely, few things undermine morale more than a sense of unfair treatment. The principle highlights the concept of "equal pay for substantially equal work under the same general working conditions." This aspect of the equity principle establishes the basis for two key concepts of comparability and competitiveness.

Comparability, sometimes called horizontal equity, means that the compensation of the uniformed services should be comparable with the nation's economy. It refers to equivalent civilian counterparts. That is, equal pay for substantially equal work. The specific items referred to here are pay, allowances, and benefits. Horizontal equity does not refer to "sameness" or "exactness," as the military duties do not have exact counterparts in the civilian world. Equal pay for substantially equal work means that all jobs, whether military or civilian, possess certain common demands for which any employer is willing to pay. The important demands include knowledge, mental and physical skills and problem-solving skills. Members of the armed forces should be paid generally what they might expect were they to apply the knowledge, skills and responsibilities of their Service jobs to jobs in civilian life.

Compensation competitiveness is needed to ensure the adequate manning of certain military specialties. "Competitiveness" refers to both external (private market pressures) and internal competition (those military duties requiring volunteer manning because of their hazardous, arduous, uncomfortable and high training investment activities). Special pay, incentive pay and other incentives, particularly in peace time, are used to ensure compensation competitiveness. During peace time, special incentives are needed for specific duties that are in high demand in the

economy or that are inherently more dangerous or uncomfortable than other peace time duties.

d. Flexibility

The compensation system ought to be designed to be flexible enough to adjust quickly to changing conditions, including combat tactics, new technology, and exogenous manpower supply and demand conditions. The principle of flexibility highlights the following key concepts:

(1) The compensation system should be economically efficient. The amount or level of military compensation should be no higher than necessary to fulfill the basic objective of attracting, retaining, and motivating the kinds and number of personnel needed for the national security.

(2) Differing supply (i.e., skill and experience profile) and demand (i.e., desired force profiles) among the uniformed services require a system with the flexibility to offer different wages for different skills to satisfy the varying needs of different military situations. This refers to the importance of special and incentive pays.

(3) The compensation system should have a rapid and equitable adjustment mechanism to reflect changes in the national economy. The compensation system of the uniformed services should be related to the national economy so that its members may participate in the gradual rise in the standard of living.

e. Motivational Aspects

Motivation relates to the need to incorporate a relationship between compensation and effort or contribution required of the individual. The system should encourage meritorious performance, advancement to higher responsibilities, and incentives to retire when efficiency of the individual starts declining.

The implications of the above principles are that: (1) civilian compensation forms the bases for military compensation, (2) total military compensation should be equal to the total civilian compensation for similar jobs, and (3) military compensation should have an automatic adjustment mechanism to retain equity and reflect changes in national labor market/economy.

3. Analysis

To identify the influence of various forms of military compensation on the enlistment decision of potential recruits, data was collected by the U.S. Army Research Institute for Behavioral and Social Sciences (ARI). New recruits entering the Regular Army were surveyed at U.S. Army reception stations across the country in 1982 and 1983. To minimize the sampling bias, only recruits without prior military service were included. A forced-choice questions method was used to identify the relative importance of motivations for enlisting for different categories of recruits.

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The forced-choice questions method asked recruits to pick the "most important reason" for enlisting from a list of ten alternative reasons. Tables 3.1-3.3 present the results. Table 3.1 compares data collected in a 1979 Department of Defense (DOD) survey and the 1982/1983 ARI survey. It indicates how reasons for enlistment have changed over time. Table 3.2 and 3.3 present the data according to AFQT scores and the educational background of recruits, respectively.

TABLE 3.1

COMPARISON OF MOST IMPORTANT REASON FOR ENLISTMENT

Most Important Reason Picked	1979 DOD Survey	K Survey 1982	1983
Chance to better myself	39	30	25
To get trained in skill	25	22	19
Money for college education	7	15	16
To serve my country	10	9	9
I was unemployed	1	10	9
To prove that I can make it	3	6	7
Earn more money	1	2	7
Travel	4	not measured	
To get away from a personal problem	7	1	2
Family tradition to serve	1	1	1
	100	100	100

Ref. 17:p. 6]

TABLE 3.2

PERCENT OF RECRUITS BY AFQT CATEGORY CLASSIFICATION

Reason for Enlistment	AFQT Category			
	I&II	IIIA	IIIB	IVA/IVB
To get trained in a skill	23.5	27.2	34.4	28.8
Money for college education	30.5	21.1	8.7	10.6
To serve my country	11.6	12.4	10.7	9.6
I was unemployed	9.5	9.6	12.5	22.3
To prove that I can make it	7.4	8.4	10.5	9.2
To be away from home	5.3	8.1	7.4	8.2
Earn more money	5.3	5.4	7.7	5.8
Travel	4.1	3.7	5.2	3.4
To get away from personal problem	1.6	1.8	1.4	1.0
Family tradition to serve	1.0	1.8	1.4	1.0
	100	100	100	100

[Ref. 17:p. 8]

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TABLE 3.3

PERCENT OF RECRUITS BY EDUCATION BACKGROUND

Reason for Enlistment	Post HSDG	HSDG	NHDG
To get trained in a skill	24.2	29.8	32.8
Money for college education	27.5	17.9	5.9
To serve my country	9.1	11.7	12.2
I was unemployed	11.7	10.3	15.6
To prove that I can make it	7.4	9.8	12.8
To be away from home	5.5	7.2	5.6
Earn more money	6.3	5.6	5.5
Travel	4.3	4.4	5.0
To get away from personal problem	3.1	2.0	2.4
Family tradition to serve	1.0	1.3	2.3
	100	100	100

[Ref. 17:p. 9]

Basic pay is the centerpiece of military compensation. Being the only cash element of compensation which every member receives, it provides maximum utility to the members of the uniformed services. Military pay relative to what the individual could earn in the private sector is the major incentive for enlistment in the U.S. Army. The conclusion is derived from the data provided in Table 3.4. It is evident from the data that military pay has the greatest relative influence on the decision of potential recruits. Recent

recruitment models (Table 3.4) show higher elasticity for pay than for advertising or unemployment.

The data provided in Table 3.1 also support the above conclusion. The most important reason for enlistment in 1979 (39%) and in 1982/1983 (30%) was "chances to better myself." This is interpreted as economic self improvement. Basic pay, being a major element of the military compensation system, contributes the most towards economic self-improvement. This reason for enlistment was approximately equal across AFQT categories and education levels.

TABLE 3.4

ELASTICITIES ESTIMATED BY RECRUITMENT MODELS

Model	Pay	Advertising	Unemployment
Brown, 83	1.0	0.05	0.60
Daula-Smith, 84	1.6	0.11	1.15
REWs, 86	2.0	--	0.85

[Ref. 12:p. 8]

Benefits, as discussed above, are the second major element of military compensation. Two benefits, "to get trained in a skill" and "money for college education," received the greatest emphasis from the recruits. "Skill training" is most frequently selected by the recruits when asked in the absence of "chances to better myself" or before that. Data in Table 3.2 and 3.3 suggest that this benefit was

important to both high quality and low quality recruits. However, lower quality recruits were more likely to emphasize the importance of receiving skills that would be useful in the civilian sector.

"Money for college education" is one of the most important incentives provided to the enlistees in the U.S. Army. Its purpose is three fold: (1) to provide financial assistance to military personnel to enable them to develop educationally and professionally while in service and to encourage them to continue their education after leaving service, (2) to aid members of the Armed Forces in their readjustment to civilian life after separation from the military, and (3) to provide incentive for recruitment of high quality soldiers.

Over the years "money for college education" has received wide acceptance among the youth population in the U.S. Numerous survey and studies have consistently found the "education incentive" to be an effective enlistment incentive that appeals to the higher quality youth population (i.e., the population that possess greater ability and leadership potential). Data from the ARI survey (Table 3.2 and 3.3) also confirms this conclusion. "Money for college education" was the most important reason for enlistment for those who were HSDG and with AFQT scores in the upper 50 percent.

From the above discussion, it appears that military pay, skill training, and money for college education have

maximum influence on the enlistment decision of potential recruits.

B. ADVERTISING

The purpose of this section is to understand the policy issues involved in advertising and its impact on the enlistment decision of potential recruits.

Advertising is one of the primary tools used, both by private business organizations and the military, for attracting people to apply for jobs. The aim is to attract the maximum number of people. If few people apply for a job, the odds of finding a strong candidate are lower than if you have many applicants from which to choose. Hawk (1967) described the "recruiting yield pyramid" (Figure 3.4) for hiring candidates. For example, if the goal is to hire/select five employees, the recruiter is required to make initial contacts (leads) with as many as 240 candidates. The pyramid indicates the mushrooming effect in trying to recruit applicants. Obviously, the yield ratio (240:5) will differ depending on the organization and the job in question. Nevertheless, a poor job of advertising will greatly limit the calibre of the people available for recruitment. Although the Army's long run marketing goals differ from private business objectives, the evaluation of advertising effectiveness can be based on similar criteria.
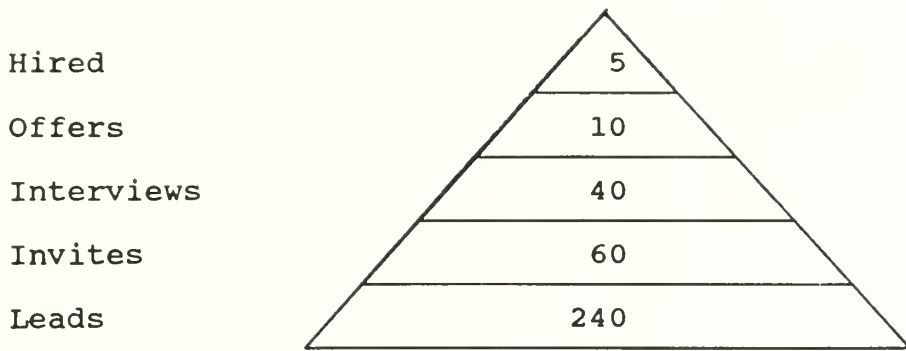
42

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Hired                          5

Offers                        10

Interviews                    40

Invites                       60

Leads                        240
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Figure 3.4

Recruiting Yield Pyramid

[Ref. 9:p. 144]

1. Advertising Policy Issues

Establishing an effective allocation of resources
means that policy makers must address a series of central
questions concerning the goals and methods of advertising
programs. A manager needs to identify a target audience,
select the contents of advertising, establish a budget,
allocate financial resources among alternative media, and
implement an optimal pattern of expenditures overtime.

a. Advertising Objectives

The optimal allocation of expenditure over time
and across media depends on the objectives of advertising,
which may vary in different circumstances. In recruiting, the
current economic environment may imply a particular strategy.
During an economic down-turn, the enlistment propensities may
be adequate even in the absence of advertising. In such a
recruiting environment, an appropriate campaign might empha-
size building a firm foundation for the future recruitment

through aiming at a younger target population. In contrast, an unexpected shortage in critical specialties might make it more appropriate to advertise in local newspapers emphasizing compensation benefits limited to particular specialties.

For the purpose of this study, interest lies in examining the effects of advertising on the production of new Army recruits, particularly "high quality" recruits who are frequently in relatively short supply. However, Army authorities may have other goals in mind for advertising. For instance, the Army may wish to (1) enhance equity across various sectors of population, (2) enhance the image or standing of its organization in the public mind over the long term, assuming that such enhancement will ultimately improve the climate for recruiting Army soldiers and officers.

b. Budget Levels and Allocation Among Media

From the advertising manager's perspective, the size of the advertising budget may be viewed as fixed in the short run. However, for the organization as a whole, advertising represents one type of resource that must compete with alternative expenditures. If the primary goal is to maximize enlistment subject to overall budget constraints, or to minimize recruitment costs subject to a given level of enlistment, the resources should be allocated so that marginal increase in recruits per unit cost is equalized for all expenditures, including advertising, pay and allowances, supplementary benefits etc.

Given an overall budget, managers must evaluate the competing media that could be used to deliver messages to the target audience. Clearly, advertising media can differ in several ways. Similar expenditures may vary by the size and demographics of the audience reached, relative penetration of the target market and the cost of deliveries. In addition, alternative media may have comparative advantages in converting qualitatively different messages. Depending on the objective of the advertising, such medium could play a role. In principle, decision about media mix should be governed by an objective criterion, for example, number of high quality recruits that will be affected by the various combination of media.

The pattern and timing of advertising campaigns is also important in achieving maximum productivity from a fixed budget. The effect of staggered bursts of intense advertising might be quite different from that of continuous flow of messages. Media productivity is probably enhanced by appropriate combinations of advertising expenditures. For example, the national electronic media could be used to covey an image and provoke an awareness or interest in Army service and subsequently print media could provide the details and facts.

2. Advertising Effectiveness

Advertising effectiveness depends on the creative and informational contents of the delivered message. The

selection of appropriate slogans is vital because advertising provides information. It is through such an awareness that the military can inform a target population of the advantages of military service and shift the propensities of youth to enlist.

During the period 1975 through 1980, the U.S. Army consistently placed third in terms of advertising recognition and appeal according to the Youth Attitude Tracking Studies (YATS) [Ref. 13:p. 71]. The advertising effort created a low propensity for enlistment in the Army by quality youth and the Army had the greatest appeal to low quality youth. The U.S. Army changed its image, awareness, and acceptability to the American youth with a dynamic advertising campaign initiated in December 1980. That is when the Army adopted the "Be All You Can Be" multi-media advertising campaign. The advertising campaign was so effective that the Army was consistently considered first relative to the other service branches, according to the YATS conducted in fall of 1982 [Ref. 13:p. 72]. The data provided in Table 3.1 also supports the effectiveness of Army advertising.

The cost effectiveness is another important consideration. Assessing the effectiveness of each advertising medium is an inherently complex problem and warrants a separate cost-benefit study. However, the U.S. Army experience may provide a valuable lesson. The RAND corporation conducted a comprehensive study for the U.S. Army to identify the effectiveness

of each advertising medium. Between 1981 and 1984, detailed information on various media expenditures was collected and allocated to local market areas on the basis of actual audience or subscriber penetration. <u>The results indicated that expenditures were significantly correlated with short run enlistment behavior</u>. The effects were found to be persistent. The results also indicated that the effectiveness of advertising budget depends on the media mix as well as the level of expenditures. Print media appeared to best promote enlistment. National radio and television also appeared to be cost effective media choices. However, the effect of local radio ads was not significantly different from zero. Table 3.5 provides marginal cost estimates based on the result.

TABLE 3.5

MARGINAL ADVERTISING COST OF OBTAINING ONE HIGH QUALITY ENLISTMENT WITHIN ONE MONTH

Medium	Marginal Cost	Implied Range of Marginal Cost (two std deviations)
Local Advertising		
Daily Newspapers	$ 3,380	$ 1,060--5,410
Weekly Newspapers	$ 1,680	$ 720--uncertain
Local Radio	uncertain	$ 5,470--uncertain
National Advertising		
Network Radio	$ 7,280	$ 5,080--12,850
Television	$ 10,120	$ 7,345--16,270
Magazines	$ 1,980	$ 1,290-- 4,200

[Ref. 18:p. 28]

C. ECONOMIC CONDITIONS

Economic conditions (i.e., the unemployment rate, etc.) is the third economic variable that influences the decisions of potential recruits. There is a direct link between the youth enlistment propensity and the state of the economy. Many recent studies have shown a close relation between unemployment and U.S. Army enlistment rates. [Dale and Gilroy, 1984; Brown, 1985; etc. [Ref. 19:p. 149]].

The recruitment models mentioned in Table 3.4 support the above hypothesis. The recruitment models indicate that an increase of 1 percent in the unemployment rate causes an average increase of approximately .85 percent in the high quality recruit supply.

The data provide in Tables 3.1-3.3 also confirms the above conclusion. The unemployment rate in the U.S. in 1982 was comparatively higher than in 1979 (i.e., 5.8% and 9.7%, respectively) [Ref. 20:p. 339]. Correspondingly, the overall percentage of recruits who enlisted because "they were unemployed" rose from 2% in 1979 to 7% in 1982/1983. However, these figures are much higher in the case of low quality recruits, as shown in Tables 3.2 and 3.3 (22.3% and 15.6%, respectively). It also highlights another important effect of unemployment. Low quality workers are affected by unemployment more than the higher quality workers.

The U.S. Army Recruiting Command (USAREC) studied the impact of unemployment on high quality recruits in 1981. The

USAREC tracked high quality contract production and total male unemployment. USAREC used a two year period from November 1981 through 1983. USAREC data (Table 3.6) shows that there is a high correlation between rising unemployment and high quality enlistment propensity.

TABLE 3.6

**RELATIONSHIP BETWEEN UNEMPLOYMENT RATE AND
ENLISTMENT PROPENSITY-HIGH QUALITY RECRUITS**

Month/Year	Unemployment Rate	Enlistment
November 1981	7.44%	2,920
January 1983	10.26%	5,080
August 1983	11.00%	5,400

[Ref. 13:p. 69]

The influence of the unemployment rate on the enlistment decisions of potential recruits suggests the following implications for the Army:

1. When unemployment is low, the supply of high quality recruits in the Army is likely to decrease. Therefore, the Army may have to substitute low quality recruits to meet its demand/quota or raise compensation.

2. When unemployment is comparatively high, as is usually the case in developing countries, there will be greater supply of labor, particularly of low quality workers. Under these circumstances, the Army can "pick and choose." Therefore, at these times, the Army can enhance the quality of Army soldiers

at the least possible cost.   However, this would necessitate accurate and reliable screening techniques at the Army level.

3.   The instability of recruit supply coupled with erratic changes in policy variables, such as pay and benefits, could lead to sudden and large changes in the level of enlistment, etc.   The best way to deal with an unstable system is by making gradual, predictable changes in policy variables.   This necessitates close coordination between the military and civilian policy makers.

The following conclusions can be inferred from the discussion in this chapter:

1.   In order to attract high quality soldiers, The Army's compensation should be at least equal to that of civilian compensation for the similar jobs.

2.   Basic pay and skill training are important incentives to both categories of the recruits.   However, education incentives are most important to high quality soldiers.

3.   A creative, well thought out and vigorously executed advertising campaign does impact recruitment.

4.   The print media and national electronic media are the most cost effective advertising media.

5.   There is a positive correlation between the unemployment rate and the propensity to enlist.   However, low quality recruits are comparatively more affected by the unemployment.

Therefore, it is concluded that:

1.   Recruitment of high quality soldiers depends on relative military compensation, advertising, and economic conditions (the unemployment rate, etc.).

2.   Advertising and increases in the unemployment rate can be used to:

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a.   enhance the quality of soldiers.

        b.   to compensate for the lower military compensation,
other things constant (i.e., quality, etc).

IV. MODEL

The purpose of this chapter is to formulate a model, based on the discussion in Chapters II and III, to minimize the Army's labor and recruitment costs while maintaining a given level of readiness.

A. READINESS

Chapter II concluded that the quality of a soldier depends on the education level, trainability, influence of environmental factors (motivation, etc.), and the amount of training imparted to the soldiers. Trainability is a function of education and is not considered as a separate factor in model formulation. The environmental influence is difficult to measure and has been considered as exogenous to the system. Therefore, for the purpose of model formulation, the quality of a soldier is expressed as a function of the education level (E) and the amount of training (T) imparted to the soldier. Mathematically this is expressed as:

$$L = f(E, T) \qquad (4.1)$$

Army readiness (Q) is its war fighting capability. Other things constant, it can be expressed using a production function, where manpower (L) and equipment (K) are combined to produce combat readiness, Q. Therefore:

$$Q = Q(K, L) \qquad (4.2)$$

Combining equations (4.1) and (4.2), army readiness can be expressed as:

$$Q = Q(K, l); \quad l = L + M(E, T)$$

Where $M_E > 0$

$\quad\quad\quad M_T > 0$

B. COSTS

Chapter III concluded that the recruitment of high quality soliders depends on relative military compensation (w), advertising expenditures (A), and the country's unemployment rate (U). In turn, the wage rate depends on the level of education, the advertising expenditure, and the unemployment rate. Therefore, military compensation can be expressed as a function of the education level, advertising expenditure, and the unemployment rate.

$$w = f(E, A, U) \tag{4.3}$$

Manpower and military equipment are the two major costs incurred by the Army to maintain its readiness. Based on equations (4.1), (4.2) and (4.3), the Army's total costs can be expressed as:

$$\text{Total Costs (C)} = w(A, U, E)L + aA + tT + rK \tag{4.4}$$

Where a, t, and r represent the unit costs of advertising, training, and military equipment respectively.

C. MODEL FORMULATION

1. The unemployment rate and the education level are assumed to be exogenous to the system. Therefore, the Army

is modeled as minimizing total costs, subject to a given level of readiness:

Minimize $C = w(a, \bar{U}, \bar{E})L + aA + tT + rK$

L, A, T, K

Subject to $Q = Q(K, 1)$; $1 = L + M(E, T)$

Where $M_E > 0$; $M_{EE} < 0$

$M_T > 0$; $M_{TT} < 0$

a. A is advertising effort (e.g., hours of effort, minutes of TV time per day, or space in newspaper, etc.).

$W_A < 0$

$W_{AA} > 0$

b. E is level of education (e.g., AFQT score, NHDG, HSDG, etc.).

$W_E > 0$

$W_{EE} < 0$

c. U is unemployment rate in the country (that is, unemployed/labor force).

$W_U < 0$

$W_{UU} > 0$

d. T is the training effort (e.g., hours, weeks, months, etc.). (It assumed that increased skill due to training is not compensated with higher wages).

2. The Langrangian expression to solve the above model is:

Minimize $\mathcal{L} = W(A, \bar{U}, \bar{E})L + aA + tT + rK$

$$+ \lambda[Q - Q(k,1)] \qquad (4.5)$$

3. The first order conditions (FOC) would be:

   a. $\mathcal{L}_L = W(A, \bar{U}, \bar{E}) - \lambda Q_l(K, 1) = 0$ (4.6)

   b. $\mathcal{L}_A = W_A(A, \bar{U}, \bar{E}) + a = 0$ (4.7)

   c. $\mathcal{L}_T = t - \lambda Q_l(K, 1) \cdot M_T = 0$ (4.8)

   d. $\mathcal{L}_K = r - \lambda Q_K(K, 1) = 0$ (4.9)

   e. $\mathcal{L}_\lambda = Q - Q(K, 1) = 0$ (4.10)

4. By solving equations (4.6) to 4.10), the optimum values of decision variables can be obtained. That is:

   a. $\overset{*}{L} = L(\bar{Q}, \bar{U}, \bar{E}, r, a, t)$

   b. $\overset{*}{A} = A(\bar{Q}, \bar{U}, \bar{E}, r, a, t)$

   c. $\overset{*}{T} = T(\bar{Q}, \bar{U}, \bar{E}, r, a, t)$

   d. $\overset{*}{K} = K(\bar{Q}, \bar{U}, \bar{E}, r, a, t)$

   e. $\overset{*}{\lambda} = \lambda(\bar{Q}, \bar{U}, \bar{E}, r, a, t)$

5. <u>Conditions to Minimize costs</u>

   a.   Equating equations (4.6), (4.8) and (4.9) provides the first condition to ensure cost minimization. That is:

$$\lambda = \frac{W}{Q_l} = \frac{t}{Q_l M_T} = \frac{r}{Q_K} \qquad (4.11)$$

Equation (4.11) implies that to minimize costs the resources should be allocated so that marginal increase in readiness per marginal cost is equalized for compensation, training, and military equipment.

   b.   Equation (4.7) provides the second condition to minimize costs: $a = -W_A$. It is evident that advertising should be used to the point where marginal costs (a) of

advertising equals the marginal impact $(- W_A)$ of advertising on reducing the wage.

    6. By the envelope theorem, the following additional results are obtained:

       a. $\dfrac{\partial \overset{*}{c}}{\partial \bar{\bar{u}}} = \dfrac{\partial \mathcal{L}}{\partial \bar{\bar{u}}} = W_u < 0$

This condition implies that an increase in unemployment leads to lower compensation.

       b. $\dfrac{\partial \overset{*}{c}}{\partial \bar{E}} = \dfrac{\partial \mathcal{L}}{\partial \bar{E}} = \dfrac{W.L - \lambda Q_l}{E} . M_E \gtrless 0$

This condition shows that education has two impacts on the Army's total costs: the wage rate increases with E but there is also an increase in the effective labor input. $W_E L$ measures the increase in labor costs as E increases. It indicates the "sensitivity" of wages to E.

      $Q_l A_E$ is greater labor available from same L with a higher E.

       c. $\dfrac{\partial \overset{*}{c}}{\partial Q} = \dfrac{\partial \mathcal{L}}{\partial Q} = \lambda > 0$

This condition states that an increase in readiness level leads to higher costs.

       d. $\dfrac{\partial \overset{*}{c}}{\partial r} , \dfrac{\partial \overset{*}{c}}{\partial \bar{a}} , \dfrac{\partial \overset{*}{c}}{\partial \bar{t}} > 0$

This condition states that an increase in unit costs of equipment, advertising or training will lead to higher costs.

7.   Comparative-Static Analysis

The following results are obtained from a comparative-static analysis.   Details of the analysis are in Appendix A.

a.   An increase in the unemployment rate will lead to a higher level of enlistment/recruitment in a given budget. Therefore, the Army can either enlist a higher number of recruits or fill its demand/quota with high quality soldiers.

b.   For a given budget, if the Army decides to enlist better educated recruits, then the number of enlistments will decrease.   As E increases, W increases.   If the budget is constant, L must decrease accordingly.   However, the higher quality recruits will be more productive.

c.   An increase in unit advertising costs will lead to a lower advertising effort.   The result will lower the quantity and/or quality of enlistments/recruitments.

d.   If unit training costs increase a higher number of soldiers is required to maintain a given level of readiness.

e.   An increase in the education of recruits will reduce the training effort. Better educated people are easier to train.

f.   When the unemployment rate increases, a lower advertising effort is required to meet the Army's demand/quota.

g.   As the education level of applicants increases, the effects of advertising become ambiguous.   In other words, increases in advertising for better educated people may

increase or decrease the Army's total costs. The logic is that better educated people are well aware of employment opportunities. This supports the conclusion drawn in Chapter III, that to attract higher quality people to the Army the advertising campaign should be creative and well thoughtout, otherwise it may have an adverse impact.

h. When the unemployment rate increases, less training is required to maintain a given level of readiness. An increase in U leads to an increase in the education of the average applicant. As the education level increases, it decreases the training required to achieve a given level of readiness.

V. CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the conclusions drawn from the
thesis and provides recommendations for improving the quality
of soldiers and the recruitment system in the Pakistan Army.

A. CONCLUSIONS

1. Due to rapid increases in the complexity of military
technology, particularly with the microelectronic revolution,
the Army's requirements for high quality soldiers is likely to
increase in the years to come.

2. "Level of education" and "scores on the aptitude
tests" of applicants are the most commonly cited determinants
of quality. Therefore, the contents of aptitude tests must be
reliable predictors of job performance. In addition,
environmental factors (motivation, etc.) and training also
influence the quality and performance of recruits.

3. The quality of soldiers can be enhanced by improving
all four factors (education level, trainability, motivation,
and training) or any combination of the individual factors.
This provides the Army with trade off opportunities.

4. High quality soldiers are relatively more combat
effective, create less discipline problems, are less expensive
to train, and enhance the Army's image and morale.

5. High quality soldiers are likely to be more expensive
because of higher compensation and recruitment resources

required to attract these individuals to Army service. However, they are more cost effective because of higher benefits gained.

6. The civilian compensation level forms the basis for military compensation. To recruit and retain the kinds and number of personnel needed, total military compensation must be at least equal to total civilian compensation for similar jobs.

7. Differing supply and demand conditions require a system with flexibility. Military compensation systems should have an automatic equitable adjustment mechanism to reflect changes in the national economy.

8. Basic pay and education incentives (money for college education) are the most important incentives for enlistment of high quality soldiers in the U.S. Army.

9. Advertising expenditures substantially affect short-run enlistment behavior. A creative and well thought out advertising campaign can have an important influence on the enlistment decision of high quality recruits.

10. The implied marginal costs of accession suggests that effectiveness of the advertising budget depends on the pattern of media buys. Statistical results indicate that national magazines and local newspaper purchases are the most effective in promoting enlistment. National radio and television also have considerable effects.

11. Economic conditions in the country, particularly the unemployment rate, have a significant effect on enlistment decision. However, low quality labor is more affected by unemployment than the high quality labor.

12. To minimize costs to the Army, subject to given level of readiness, resources should be allocated so that the marginal increase in readiness per unit cost is equalized for compensation, training, and military equipment.

B. RECOMMENDATIONS

The Pakistan Army is one of the finest armies in the world. However, it can only maintain its image by continuously improving the level of technology and the quality of its manpower. This study concentrates only on the second factor, manpower. The following recommendations, based on the findings of the thesis, are offered for improving the quality of soldiers and the recruitment system in the Pakistan Army:

1. In order to improve the quality of soldiers, the concept of "quality soldier" needs to be introduced in the Army. An Army level study should be conducted to define "high quality" soldier. The criteria used by the U.S. Army for this purpose can serve as a useful guide.

2. In order to attract high quality soldiers in the Army, it is important to identify important incentives which appeal to quality workers. Therefore, a biannual survey (on the lines of ARI survey mentioned in the thesis) should be conducted at the Army level for this purpose.

3. In addition to the basic pay, "education incentives" are the most important reason for enlistment of high quality soldiers in the U.S. Army. The following recommendations are offered in this regard:

a. It may not be economically feasible to implement this idea on a large scale in the Pakistan Army. However, this incentive should be studied in more detail to see the possibility of implementing it in the Pakistan Army on a limited scale.

b. Basic pay is the most important element of military compensation. To attract higher quality soldiers in the Army, the compensation provided to the Army personnel must be brought to a par with the civilian compensation level for similar jobs.

4. Favorable timings for introducing a new concept plays an important role in the success/failure of the concept. The study suggests that, other things being equal, the best time to introduce the concept of "quality soldier" in the Pakistan Army is when there is comparatively high rate of unemployment in the country (i.e., when there is less competition in the labor market). Therefore, this concept should be introduced as early as possible, before substantial growth in the industrial base makes it harder for the Army to compete in the labor market.

5. The influence of environmental factors on the quality of soldiers also needs to be considered. Presently, there is

a wide gap (social, economic, and moral) between leaders and the led in the Army. The study suggests that the quality of soldiers can be enhanced by improving environmental factors. Therefore, necessary measures should be taken to improve this aspect. In addition to efforts by leaders at all levels, introducing the concept of "quality soldier" will greatly assist in reducing this gap.

6. The following recommendations are offered to improve the recruitment system in the Pakistan Army:

a. To attract high quality soldiers in the Army, a vigorous and creative advertising campaign is necessary. Special attention should be paid to selecting the "slogan" and contents of the advertisements. To increase general awareness about army life and its incentives, special programs should be broadcasted on national television and local radio stations. National magazines and newspapers, being most cost effective, can be used to provide details about programs and recruitment schedules.

b. To identify high quality recruits, written tests should be modified in the light of this study. The contents of the tests should be valid predictors of soldier quality.

7. The model developed in this study could not be tested because data about the Pakistan Army was not available. A follow up study should be conducted to validate and further improve the model.

APPENDIX

COMPARATIVE-STATIC ANALYSIS

The purpose of this appendix is to determine the effects of changes in various parameters $(Q, \bar{E}, \bar{U}, r, a, t)$ on the optimum values of decision variables (L^*, T^*, A^*, K^*). To calculate effects of all changes, on all variables, is beyond the scope of this thesis. Therefore, only those effects which are considered important and have been discussed in this thesis are calculated here. The effects of remaining changes in parameters can be calculated in a similar manner.

In order to calculate effect of changes in the parameters, a three step procedure was followed. First, equations (4.6) to (4.10) were totally differentiated and converted into matrix equation for all parameter changes. Second, the sign of Jacobian was determined. Third, the sign of the effect of various changes in parameters was determined using Cramer's rule.

A. STEP 1 - DIFFERENTIALS

1. Total Differentials

By the implicit function theorem, total differentials of equations (4.5) to (4.9) are:

a. $W_A d_A + W_U dU + W_E dE - \lambda Q_{lK} dK - \lambda Q_{lK} dl - Q_l d\lambda = 0$ (1)

b. $(W_{AA} dA + W_{AU} dU + W_{AE} dE) \cdot L + W_A dL + d\,a = 0$ (2)

c. $dt - \lambda Q_{lK} \cdot M_T dk - \lambda Q_{ll} dl - \lambda Q_L M_T d\lambda$ (3)

$\qquad - \lambda Q_L (M_{TE} dE + M_{TT} dT) = 0$

d. $dr - \lambda Q_{Kl} dl - \lambda Q_{KK} dK - Q_K d\lambda = 0$ (4)

e. $dQ - Q_K dK - Q_l dl = 0$ (5)

2. Matrix Equations

a. Let $dE - dU = dt = dr = da = 0$ and $dQ \neq 0$ dividing equations (1) to (5) by dQ we get:

$-\lambda Q_{ll}$	W_A	$-\lambda Q_{ll} M_T$	$-\lambda Q_{lK}$	$-Q_l$	$\dfrac{\partial \overset{*}{L}}{\partial Q}$		0
W_A	W_{AAL}	0	0	0	$\dfrac{\partial \overset{*}{A}}{\partial Q}$		0
$-\lambda Q_{ll} \cdot M_T$	0	$-\lambda Q_l \cdot M_{TT} = 0$ $-\lambda Q_{ll} \cdot (M_T)^2$	$-\lambda Q_{lK} \cdot M_T$	$-Q_l \cdot M_T$	$\dfrac{\partial \overset{*}{T}}{\partial Q}$	=	0
$-\lambda Q_{Kl}$	0	$-\lambda Q_{Kl} \cdot M_T$	$-\lambda Q_{KK}$	$-Q_K$	$\dfrac{\partial \overset{*}{K}}{\partial Q}$		0
$-Q_l$	0	$-Q_l \cdot M_T$	$-Q_K$	0	$\dfrac{\partial \overset{*}{\lambda}}{\partial Q}$		-1

$$
\begin{bmatrix}
-\lambda Q_{II} & W_A & -\lambda Q_{II}M_T & -\lambda Q_{IK} & -Q_I \\
W_A & W_{AA.L} & O & O & O \\
-\lambda Q_{II}.M_T & O & \begin{array}{c}-\lambda Q_I.M_{TT}=O \\ -\lambda Q_{II}.(M_T)^2\end{array} & -\lambda Q_{IK}.M_T & -Q_I.M_T \\
-\lambda Q_{KI} & O & -\lambda Q_{KI}.M_T & -\lambda Q_{KK} & -Q_K \\
-Q_I & O & -Q_I.M_T & -Q_K & O
\end{bmatrix}
\begin{bmatrix}
\dfrac{\partial \overset{*}{L}}{\partial E} \\[1em]
\dfrac{\partial \overset{*}{A}}{\partial E} \\[1em]
\dfrac{\partial \overset{*}{T}}{\partial E} \\[1em]
\dfrac{\partial \overset{*}{K}}{\partial E} \\[1em]
\dfrac{\partial \overset{*}{\lambda}}{\partial E}
\end{bmatrix}
=
\begin{bmatrix}
-W_E \\[1em]
-W_{AE}.L \\[1em]
-\lambda Q_I.M_{TE} \\[1em]
O \\[1em]
O
\end{bmatrix}
$$

$$
\begin{bmatrix}
-\lambda Q_{II} & W_A & -\lambda Q_{II} M_T & -\lambda Q_{IK} & -Q_I \\
W_A & W_{AA.L} & O & O & O \\
-\lambda Q_{II}.M_T & O & \begin{matrix}-\lambda Q_I.M_{TT}=O \\ -\lambda Q_{II}.(M_T)^2\end{matrix} & -\lambda Q_{IK}.M_T & -Q_I.M_T \\
-\lambda Q_{KI} & O & -\lambda Q_{KI}.M_T & -\lambda Q_{KK} & -Q_K \\
-Q_I & O & -Q_I.M_T & -Q_K & O
\end{bmatrix}
\begin{bmatrix}
\dfrac{\partial \overset{*}{L}}{\partial U} \\[2ex]
\dfrac{\partial \overset{*}{A}}{\partial U} \\[2ex]
\dfrac{\partial \overset{*}{T}}{\partial U} \\[2ex]
\dfrac{\partial \overset{*}{K}}{\partial U} \\[2ex]
\dfrac{\partial \overset{*}{\lambda}}{\partial U}
\end{bmatrix}
=
\begin{bmatrix}
-W_U \\[2ex]
-W_{AU} \\[2ex]
O \\[2ex]
O \\[2ex]
O
\end{bmatrix}
$$

Let $dE = du = da = dr = d\bar{Q} = 0$ and $dt \neq 0$

$$
\begin{bmatrix}
-\lambda Q_{II} & W_A & -\lambda Q_{II}M_T & -\lambda Q_{IK} & -Q_I \\
W_A & W_{AAL} & 0 & 0 & 0 \\
-\lambda Q_{II}\cdot M_T & 0 & \begin{matrix}-\lambda Q_I\cdot M_{TT}=0 \\ -\lambda Q_{II}\cdot(M_T)^2\end{matrix} & -\lambda Q_{IK}\cdot M_T & -Q_I\cdot M_T \\
-\lambda Q_{KI} & 0 & -\lambda Q_{KI}\cdot M_T & -\lambda Q_{KK} & -Q_K \\
-Q_I & 0 & -Q_I & -Q_K & 0
\end{bmatrix}
\begin{bmatrix}
\dfrac{\partial \overset{*}{L}}{\partial t} \\[8pt]
\dfrac{\partial \overset{*}{A}}{\partial t} \\[8pt]
\dfrac{\partial \overset{*}{T}}{\partial t} \\[8pt]
\dfrac{\partial \overset{*}{K}}{\partial t} \\[8pt]
\dfrac{\partial \overset{*}{\lambda}}{\partial t}
\end{bmatrix}
=
\begin{bmatrix}
0 \\[8pt]
0 \\[8pt]
-1 \\[8pt]
0 \\[8pt]
0
\end{bmatrix}
$$

e. Let $dE = du = dt = dr = d\bar{Q} = O$ and $da \neq O$

$$
\begin{bmatrix}
-\lambda Q_{II} & W_A & -\lambda Q_{II}M_T & -\lambda Q_{IK} & -Q_I \\
W_A & W_{AAL} & O & O & O \\
-\lambda Q_{II}.M_T & O & \begin{array}{c}-\lambda Q_I.M_{TT}=O \\ -\lambda Q_{II}.(M_T)^2\end{array} & -\lambda Q_{IK}.M_T & -Q_I.M_T \\
-\lambda Q_{KI} & O & -\lambda Q_{KI}.M_T & -\lambda Q_{KK} & -Q_K \\
-Q_I & O & -Q_I & -Q_K & O
\end{bmatrix}
\begin{bmatrix}
\dfrac{\partial \overset{*}{L}}{\partial a} \\[2ex]
\dfrac{\partial \overset{*}{A}}{\partial a} \\[2ex]
\dfrac{\partial \overset{*}{T}}{\partial a} \\[2ex]
\dfrac{\partial \overset{*}{K}}{\partial a} \\[2ex]
\dfrac{\partial \overset{*}{\lambda}}{\partial a}
\end{bmatrix}
=
\begin{bmatrix}
O \\
-1 \\
O \\
O \\
O
\end{bmatrix}
$$

$$
\begin{bmatrix}
-\lambda Q_{II} & W_A & -\lambda Q_{II}M_T & -\lambda Q_{IK} & -Q_I \\
W_A & W_{AAL} & 0 & 0 & 0 \\
-\lambda Q_{II}\cdot M_T & 0 & -\lambda Q_I\cdot (M_T)^2 - \lambda Q_{II}\cdot M_{TT} & -\lambda Q_{IK}\cdot M_T & -Q_I\cdot M_T \\
-\lambda Q_{KI} & 0 & -\lambda Q_{KI}\cdot M_T & -\lambda Q_{KK} & -Q_K \\
-Q_I & 0 & -Q_I\cdot M_T & -Q_K & 0
\end{bmatrix}
\begin{bmatrix}
\dfrac{\partial \overset{*}{L}}{\partial r} \\[2mm]
\dfrac{\partial \overset{*}{A}}{\partial r} \\[2mm]
\dfrac{\partial \overset{*}{A}}{\partial r} \\[2mm]
\dfrac{\partial \overset{*}{K}}{\partial r} \\[2mm]
\dfrac{\partial \overset{*}{\lambda}}{\partial r}
\end{bmatrix}
=
\begin{bmatrix}
0 \\
0 \\
0 \\
-1 \\
0
\end{bmatrix}
$$

B.   STEP 2 - JACOBIAN

1.   Jacobian is the determinant of the matrix equation. Its value is determined as follows:

$$|J| = \begin{vmatrix} -\lambda Q_{ll} & W_A & -\lambda Q_{ll}M_T & -Q_{KK} & -Q_l \\ W_A & W_{AA}L & 0 & 0 & 0 \\ -\lambda Q_{ll}M_T & 0 & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_lM_T \\ -\lambda Q_{Kl} & 0 & -\lambda Q_{lK}M_T & -\lambda Q_{KK} & -Q_K \\ -Q_l & 0 & -\lambda Q_lM_T & -Q_K & 0 \end{vmatrix}$$

$|J| = [\,|J_1| + |J_2|\,] < 0$ Determination of $|J_1|$ and $|J_2|$ is shown below:

$$|J_1| = -w_A \begin{vmatrix} W_A & 0 & 0 & 0 \\ -\lambda Q_{ll}M_T & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_lM_T \\ -\lambda Q_{Kl} & -\lambda Q_{lK}M_T & -\lambda Q_{KK} & -Q_K \\ -Q_l & -\lambda Q_lM_T & -Q_K & 0 \end{vmatrix}$$

$$|J_1| = (-w_A)(w_A) \begin{vmatrix} -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_lM_T \\ -\lambda Q_{lK}M_T & -\lambda Q_{KK} & -Q_K \\ -\lambda Q_lM_T & -Q_K & 0 \end{vmatrix}$$

Therefore, $|J_1| < 0$

$$J_2 = w_{\lambda\lambda} L \begin{vmatrix} -\lambda Q_{ll} & -\lambda Q_{ll} M_T & -Q_{KK} & -Q_l \\ -\lambda Q_{ll} M_T & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK} M_T & -Q_l M_T \\ -\lambda Q_{Kl} & -\lambda Q_{lK} M_T & -\lambda Q_{KK} & -Q_K \\ -Q_l & -\lambda Q_l M_T & -Q_K & 0 \end{vmatrix}$$

Now $|J_2| = |J_3| + |J_4| + |J_5|$; where

$$|J_3| = Q_l \begin{vmatrix} -\lambda Q_{ll} M_T & -Q_{KK} & -Q_l \\ -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK} M_T & -Q_l M_T \\ -\lambda Q_{lK} M_T & -\lambda Q_{KK} & -Q_K \end{vmatrix} < 0$$

$$|J_4| = -Q_l M_T \begin{vmatrix} -\lambda Q_{ll} & -Q_{KK} & -Q_l \\ -\lambda Q_{ll} M_T & -\lambda Q_{lK} M_T & -Q_l M_T \\ -\lambda Q_{Kl} & -\lambda Q_{KK} & -Q_K \end{vmatrix} < 0$$

$$J_5| = Q_k \begin{vmatrix} -\lambda Q_{ll} & -\lambda Q_{ll} M_T & -Q_l \\ -\lambda Q_{ll} M_T & -\lambda Q_{ll}(M_T)^2 & -Q_l M_T \\ -\lambda Q_{Kl} & -\lambda Q_{lK} M_T & -Q_K \end{vmatrix} \underset{>}{\overset{<}{_-}} 0$$

Since $|J_5|$ is ambiguous, therefore second order conditions are necessary to determine the sign of Jacobian.

2. Second order conditions

In a constrained minimum, the value of $|\bar{H}_2|$, $|\bar{H}3|$, . . . $|\bar{H}_n| < 0$, where $|\bar{H}|$ is called bordered Hessian and it is the determinant of second order conditions as shown below:

$$
|\bar{H}| = \begin{vmatrix}
0 & Q_l(K,1) & 0 & Q_l(K,1)M_T & Q_K(K,1) \\
Q_l(K,1) & -\lambda Q_{ll} & W_A & 0 & -\lambda Q_{lK} \\
0 & W_A & W_{AA} & 0 & 0 \\
Q_l(K,1)M_T & 0 & 0 & -\lambda Q_{ll}M_{TT} & -\lambda Q_{lK} \\
Q_K(K,1) & -\lambda Q_{Kl} & 0 & -\lambda Q_{Kl}M_T & -\lambda Q_{KK}
\end{vmatrix}
$$

$$
|\bar{H}_2| = \begin{vmatrix}
0 & Q_l(K,1) & 0 \\
Q_l(K,1) & -\lambda Q_{ll} & W_A \\
0 & W_A & W_{AA}
\end{vmatrix} < 0
$$

$$
|\bar{H}_3| = \begin{vmatrix}
0 & Q_l(K,1) & 0 & Q_l(K,1)M_T \\
Q_l(K,1) & -\lambda Q_{ll} & W_A & 0 \\
0 & W_A & W_{AA} & 0 \\
Q_l(K,1)M_T & 0 & 0 & -\lambda Q_{ll}M_{TT}
\end{vmatrix} =>
$$

$$-Q_l M_T \begin{vmatrix} Q_l(K,l) & 0 & Q_l(K,l)M_T \\ -\lambda Q_{ll} & W_A & 0 \\ W_A & W_{AA} & 0 \end{vmatrix} < 0$$

$|\bar{H}_3| < 0$ on the assumption that $|\lambda Q_{ll} wAA| > |W_A W_A|$

Since $|\bar{H}_2|$ and $|\bar{H}_3|$ are both negative, it is assumed that $|\bar{H}_4|$ is also negative. Therefore, sign of the Jacobian is negative, or the Jacobian is non-zero.

C. STEP 3 – EFFECTS OF CHANGES IN PARAMETERS ON THE OPTIMUM VALUES OF DECISION VARIABLES

1. Effects on Manpower

a. $\dfrac{\partial L^*}{\partial U}$ $\dfrac{|A|}{|J|}$, where,

$$|A| = \begin{vmatrix} -W_U & W_A & -Q_{ll}M_T & -Q_{lK} & -Q_l \\ -W_{AU} & W_{AA}L & 0 & 0 & 0 \\ 0 & 0 & -Q_{ll}(M_T)^2 & -Q_{lK}M_T & -Q_l M_T \\ 0 & 0 & -Q_{Kl}M_T & -Q_{KK} & -Q_K \\ 0 & 0 & -Q_l M_T & -Q_K & 0 \end{vmatrix} \Rightarrow$$

$$|A| = |A_1| + |A_2|$$

$$|A_1| = w_U \begin{vmatrix} w_{AA}L & 0 & 0 & 0 \\ 0 & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_lM_T \\ 0 & -\lambda Q_{Kl}M_T & -\lambda Q_{KK} & -Q_K \\ 0 & -\lambda Q_lM_T & -Q_K & 0 \end{vmatrix}$$

The sign of $|A_1|$ is negative, as already calculated in Jacobian (J_1). Therefore, $|A_1| < 0$.

$$|A_2| = -w_{AU} \begin{vmatrix} w_A & -\lambda Q_{ll}M_T & -\lambda Q_{lK} & -Q_l \\ 0 & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_lM_T \\ 0 & -\lambda Q_{Kl}M_T & -\lambda Q_{KK} & -Q_K \\ 0 & -\lambda Q_lM_T & -Q_K & 0 \end{vmatrix} =>$$

$$|A_2| = -w_{AU} \begin{vmatrix} -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q1M_T \\ -\lambda Q_{Kl}M_T & -\lambda Q_{KK} & -Q_K \\ -\lambda Q_lM_T & -Q_K & 0 \end{vmatrix} < 0$$

Since $|A| = |A_1| + |A_2|$, therefore, $|A| < 0$

(6)

The interpretation of equation (6) is that an increase in the unemployment rate will lead to higher labor effort both in terms of quantity and quality. That means that the Army can either recruit a higher number of recruits at the given budget or keep the recruitment/enlistment as fixed and recruit/enlist

higher quality soldiers. In both case, the total labor effort will increase.

b. $\dfrac{\partial L^*}{\partial E} \quad \dfrac{|A|}{|J|}$, where,

$$|A| = \begin{vmatrix} -w_E & w_A & -Q_{ll}M_T & -Q_{lK} & -Q_l \\ -w_{AE}L & w_{AA}L & 0 & 0 & 0 \\ -\lambda Q_l M_{TE} & 0 & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_l M_T \\ 0 & 0 & -\lambda Q_{Kl}M_T & -\lambda Q_{KK} & -Q_K \\ 0 & 0 & -\lambda Q_l M_T & -Q_K & 0 \end{vmatrix} \Rightarrow$$

$$|A| = |A_1| + |A_2| \; , \text{ where}$$

$$|A_1| = -w_A \begin{vmatrix} -w_{AE}L & 0 & 0 & 0 \\ -\lambda Q_l M_{TE} & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_l M_T \\ 0 & -\lambda Q_{Kl}M_T & -\lambda Q_{KK} & -Q_K \\ 0 & -\lambda Q_l M_T & -Q_K & 0 \end{vmatrix} \Rightarrow$$

$$|A_1| = (-w_A)(-w_{AE}L) \begin{vmatrix} -\lambda Q11(M_T)^2 & -\lambda Q_{lK}M_T & -Q_l M_T \\ -\lambda Q_{Kl}M_T & -\lambda Q_{KK} & -Q_K \\ -\lambda Q_l M_T & -\lambda Q_K & 0 \end{vmatrix} > 0$$

$$|A_2| = w_{AA}L \begin{vmatrix} -w_E & -\lambda Q_{ll}M_T & -\lambda Q_{lK} & -Q_l \\ -\lambda Q_l M_{TE} & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_l M_T \\ 0 & -\lambda Q_{Kl}M_T & -\lambda Q_{KK} & -Q_K \\ 0 & -\lambda Q_l M_T & -Q_K & 0 \end{vmatrix} =>$$

Now $|A_2| = |A_3| + |A_4|$, where

$$|A_3| = -w_E \begin{vmatrix} -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_l M_T \\ -\lambda Q_{Kl}M_T & -\lambda Q_{KK} & -Q_K \\ -\lambda Q_l M_T & -Q_K & 0 \end{vmatrix} = 0 \quad \text{and}$$

$$|A_3| = \lambda Q_l M_{TE} \begin{vmatrix} -\lambda Q_{ll}M_T & -\lambda Q_{lK} & -Q_l \\ -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_l M_T \\ -\lambda Q_l M_T & -Q_K & 0 \end{vmatrix} = 0$$

Value of both $|A_3|$ and $|A_4|$ is zero. Therefore, $|A_2| = 0$ and $|A| = |A_1|$.

$$\frac{|\partial L^*|}{|\partial E|} < 0 \tag{7}$$

The interpretation of equation (7) is that when E increases, w increases and L decreases because of the fixed budget. Therefore, an increase in education will lead to a lower number of soldiers because of the fixed budget.

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However, they will be more productive.

c. $\dfrac{\partial L^*}{\partial a} = \dfrac{|A|}{|J|}$, where

$$|A| = \begin{vmatrix} 0 & W_A & -Q_{ll}M_T & -Q_{lK} & -Q_l \\ -1 & W_{AA}L & 0 & 0 & 0 \\ 0 & 0 & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_lM_T \\ 0 & 0 & -\lambda Q_{Kl}M_T & -\lambda Q_{KK} & -Q_K \\ 0 & 0 & -\lambda Q_lM_T & -Q_K & 0 \end{vmatrix} \Rightarrow$$

$$|A| = W_A \begin{vmatrix} -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_lM_T \\ -\lambda Q_{Kl}M_T & -\lambda Q_{KK} & -Q_K \\ -\lambda Q_lM_T & -Q_K & 0 \end{vmatrix} > 0$$

Therefore, $\dfrac{\partial L^*}{\partial a} < 0$ (8)

According to equation (8) any increase in unit costs of advertising will reduce advertising and lower the level of recruitment or enlistment.

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d. $\dfrac{\partial L^*}{\partial t} = \dfrac{|A|}{|J|}$, where

$$|A| = \begin{vmatrix} 0 & W_A & -Q_{ll}M_T & -Q_{lK} & -Q_l \\ 0 & W_{AA}L & 0 & 0 & 0 \\ -1 & 0 & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_l M_T \\ 0 & 0 & -\lambda Q_{Kl}M_T & -\lambda Q_{KK} & -Q_K \\ 0 & 0 & -\lambda Q_l M_T & -Q_K & 0 \end{vmatrix} \Rightarrow$$

$$|A| = W_{AA}L \begin{vmatrix} -Q_{ll}M_T & -Q_{lK} & -Q_l \\ -\lambda Q_{Kl}M_T & -\lambda Q_{KK} & -Q_K \\ -\lambda Q_l M_T & -Q_K & 0 \end{vmatrix} < 0 \Rightarrow$$

$$\dfrac{\partial L^*}{\partial t} = \dfrac{|A|}{|J|} > 0 \tag{9}$$

According to equation (9) when unit cost of training increases, a higher number of soldiers is required to maintain a given level of readiness.

2.   **Effects On Training**

a. $\dfrac{\partial T^*}{\partial E} = \dfrac{|A|}{|J|}$,   where

$$|A| = \begin{vmatrix} -\lambda Q_{ll} & W_A & W_E & -Q_{lK} & -Q_l \\ W_A & W_{AA}L & W_{AE}L & 0 & 0 \\ -\lambda Q_{ll}M_T & 0 & -\lambda Q_{ll}M_{TE} & -\lambda Q_{lK}M_T & -Q_l M_T \\ -\lambda Q_{Kl} & 0 & 0 & -\lambda Q_{KK} & -Q_K \\ -Q_l & 0 & 0 & -Q_K & 0 \end{vmatrix} \Rightarrow$$

$$|A| = |A_1| + |A_2|$$

$$|A_1| = -Q_l \begin{vmatrix} W_A & W_E & -Q_{lK} & -Q_l \\ W_{AA}L & W_{AE}L & 0 & 0 \\ -\lambda Q_{ll}M_{TE} & -\lambda Q_{lK}M_T & -Q_l M_T \\ 0 & 0 & -\lambda Q_{KK} & -Q_K \end{vmatrix} > 0$$

$$|A_2| = Q_K \begin{vmatrix} -\lambda Q_{ll} & W_A & W_E & -Q_l \\ W_A & W_{AA}L & W_{AE}L & 0 \\ -\lambda Q_{ll}M_T & 0 & -\lambda Q_{ll}M_{TE} & -Q_l M_T \\ -\lambda Q_{KK} & 0 & 0 & -Q_K \end{vmatrix} > 0$$

Therefore, $|A| > 0$ and $\dfrac{\partial T^*}{\partial E} < 0$ (10)

According to equation (10) an increase in the education level of soldiers will reduce the training required. This is obvious because more highly educated people are easier and less expensive to train.

b. $\dfrac{\partial T^*}{\partial U} = \dfrac{|A|}{|J|}$, where

$$|A| = \begin{vmatrix} -\lambda Q_{ll} & W_A & W_U & -Q_{lK} & -Q_l \\ W_A & W_{AA}L & W_{AU} & 0 & 0 \\ -\lambda Q_{ll}M_T & 0 & 0 & -\lambda Q_{lK}M_T & -Q_lM_T \\ -\lambda Q_{Kl} & 0 & 0 & -\lambda Q_{KK} & -Q_K \\ -Q_l & 0 & 0 & -Q_K & 0 \end{vmatrix} \Rightarrow$$

Since $W_{AU} = 0$, therefore:

$$|A| = \begin{vmatrix} W_A & W_{AA}L & 0 & 0 \\ -\lambda Q_{ll}M_T & 0 & -\lambda Q_{lK}M_T & -Q_lM_T \\ -\lambda Q_{Kl} & 0 & -\lambda Q_{KK} & -Q_K \\ -Q_l & 0 & -Q_K & 0 \end{vmatrix} > 0 \quad \Rightarrow$$

$$\dfrac{\partial T^*}{\partial U} < 0 \tag{11}$$

According to equation (11) if unemployment increases, less training is required to maintain a given level of readiness. This is because an increase in U increases the level of education in the average recruit which decreases the training required.

3. **Effects On Advertising**

a. $\dfrac{\partial A^*}{\partial U} = \dfrac{|A|}{|J|}$, where

$$|A| = \begin{vmatrix} -\lambda Q_{ll} & -w_U & -\lambda Q_{ll}M_T & -\lambda Q_{lK} & -Q_l \\ w_A & -w_{AU} & 0 & 0 & 0 \\ -\lambda Q_{ll}M_T & 0 & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_l M_T \\ -\lambda Q_{Kl} & 0 & -\lambda Q_{lK}M_T & -\lambda Q_{KK} & -Q_K \\ -Q_l & 0 & -Q_l M_T & -Q_K & 0 \end{vmatrix} \Rightarrow$$

Since $-w_U > 0$; and $w_A < 0$

Similarly $-w_{AU} < 0$; and $w_{AA}L > 0$

Therefore, sign of $|A|$ will be opposite of $|J|$

determined in step 2 above. Hence, $\dfrac{\partial A^*}{\partial U} < 0$ \qquad (12)

According to equation (12), if rate of unemployment increases, then lower advertising effort is required to meet the Army demand/quota.

b. $\dfrac{\partial A^*}{\partial E} = \dfrac{|A|}{|J|}$, where

$$|A| = \begin{vmatrix} -\lambda Q_{ll} & -w_E & -\lambda Q_{ll}M_T & -\lambda Q_{lK} & -Q_l \\ w_A & -w_{AE}L & 0 & 0 & 0 \\ -\lambda Q_{ll}M_T & -\lambda Q_l M_{TE} & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_l M_T \\ -\lambda Q_{Kl} & 0 & -\lambda Q_{lK}M_T & -\lambda Q_{KK} & -Q_K \\ -Q_l & 0 & -Q_l M_T & -Q_K & 0 \end{vmatrix} \Rightarrow$$

$$|A| = |A_1| + |A_2| \text{ , where}$$

$$|A_1| = -w_A \begin{vmatrix} -w_E & -\lambda Q_{ll}M_T & -\lambda Q_{lK} & -Q_l \\ -\lambda Q_l M_{TE} & -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_l M_T \\ 0 & -\lambda Q_{lK}M_T & -\lambda Q_{KK} & -Q_K \\ 0 & -Q_l M_T & -Q_K & 0 \end{vmatrix} =>$$

$$|A_1| = (|A_3| + |A_4|)(-w_A) \text{ , where}$$

$$|A_3| = -w_E \begin{vmatrix} -\lambda Q_{ll}(M_T)^2 & -\lambda Q_{lK}M_T & -Q_l M_T \\ -\lambda Q_{lK}M_T & -\lambda Q_{KK} & -Q_K \\ -Q_l M_T & -Q_K & 0 \end{vmatrix} > 0$$

$$|A_4| = -\lambda Q_l M_T \begin{vmatrix} -\lambda Q_{ll}M_T & -\lambda Q_{lK} & -Q_l \\ -\lambda Q_{lK}M_T & -\lambda Q_{KK} & -Q_K \\ -Q_l M_T & -Q_K & 0 \end{vmatrix} < 0$$

$$\text{Therefore, } |A_1| \gtrless 0$$

$$|A_2| = -w_{AE}L \begin{vmatrix} -\lambda Q_{\iota\iota} & -\lambda Q_{\iota\iota}M_T & -\lambda Q_{\iota K} & -Q_\iota \\ -\lambda Q_{\iota\iota}M_T & -\lambda Q_{\iota\iota}(M_T)^2 & -\lambda Q_{\iota K}M_T & -Q_\iota M_T \\ -\lambda Q_{K\iota} & -\lambda Q_{\iota K}M_T & -\lambda Q_{KK} & -Q_K \\ -Q_\iota & -Q_\iota M_T & -Q_K & 0 \end{vmatrix} \Rightarrow$$

Now $|A_2| = (|A_5| + |A_6| + |A_7|)(-w_{AE}L)$, where

$$|A_5| = Q_\iota \begin{vmatrix} -\lambda Q_{\iota\iota}M_T & -\lambda Q_{\iota K} & -Q_\iota \\ -\lambda Q_{\iota\iota}(M_T)^2 & -\lambda Q_{\iota K}M_T & -Q_\iota M_T \\ -\lambda Q_{\iota K}M_T & -\lambda Q_{KK} & -Q_K \end{vmatrix} = 0$$

$$|A_6| = -w_{AE}L \begin{vmatrix} -\lambda Q_{\iota\iota} & -\lambda Q_{\iota K} & -Q_\iota \\ -\lambda Q_{\iota\iota}M_T & -\lambda Q_{\iota K}M_T & -Q_\iota M_T \\ -\lambda Q_{K\iota} & -\lambda Q_{KK} & -Q_K \end{vmatrix} = 0$$

$$|A_7| = Q_K \begin{vmatrix} -\lambda Q_{\iota\iota} & -\lambda Q_{\iota\iota}M_T & -Q_\iota \\ -\lambda Q_{\iota\iota}M_T & -\lambda Q_{\iota\iota}(M_T)^2 - Q_\iota M_T \\ -\lambda Q_{K\iota} & -\lambda Q_{\iota K}M_T & -Q_K \end{vmatrix} = 0 \Rightarrow |A_2| = 0$$

Therefore, $|A| = |A_1|$ and $\dfrac{\partial A^*}{\partial E} \begin{matrix} < \\ \backslash \\ > \end{matrix} 0$ (13)

According to equation (13) the effect of higher education of people on advertising effort is ambiguous. That is, if education level of people increases, then, advertising effort might be increased or decreased subject to the prevailing situation. Before reaching any final conclusion, this would require validation/confirmation when actual data is available. However, it adds to the conclusion drawn in Chapter III that to attract higher quality soldiers to the Army a creative and well thought out advertising campaign is required.

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